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Contributions to the knowledge of North American Sphagna. II.

C. WARNSTORF.

b. Stem leaves broadest at the base, distinctly narrowed upward, therefore more or less isosceles-triangular, mostly with an involute, truncate and dentate apex. Border much widened downward.

a. Stem leaves with or without fibrils in the upper half. Superficial cells of the stem cortex with very distant, irregularly disposed, ringless pores. Wood body never red or brown, generally yellowish or greenish. Branch leaves for the most part distinctly five-ranked, appressed or curved spreading. Usually monoicous, rarely dioicous; male branches red.

7. *S. quinquefarium* (BRAITHW.) WARNST. Hedw., 1885, p. 222-224.

Syn.: *S. acutifolium*, var. *quinquefarium* Braith. Sphagn. Eur. and N. Amer. (1880).

S. acutifolium, varr. *pachycladum* et *alpinum* Sendt.

S. acutifolium, var. *flaviculo* Warnst. Europ. Torfm. p. 50 (1881); var. *Gerstenbergeri* Warnst. Flora, 1882, p. 206; varr. *pallens* et *Silesiacum* Warnst. Hedw. 1884, p. 116 and 118.

S. plumosum Röll., var. *quinquefarium* (Braithw.); var. *Gerstenbergeri* (Warnst.); var. *Silesiacum* (Warnst.) Flora, 1886.

S. Warnstorfii Röll, var. *pallens*, (Warnst.); var. *pseudo petulum* Röll, Syst. der Torfm. Flora, 1886.

Plants slender and delicate like S. Warnstorfii or strong and robust like S. Russowii, in looser and denser, higher or lower tufts; color pale, grayish green to grass-green, the heads often brown, fine rose-color, or violet red.

Wood cylinder whitish or straw-yellow, very seldom in some parts of the stem with a flush of red; cells pitted.

Stem cortex composed of three or four layers; cells of medium width and thin-walled, the outer walls of the peripheral layer with very distant irregularly disposed membrane-thinnings which often, however, appear like ringless pores. Inner cells porose.

Stem leaves from a broad base deltoid, not linguiform, above at the often abruptly contracted apex truncate, dentate, usually involute and bordered at the edge; the border much widened below, and constructed of very narrow green pitted cells. Hyaline cells in the whole middle part of the leaf

broad, in the upper half almost rhombic, in the lower rhomboidal, often once or several times divided by obliquely transverse walls, and with membrane-plaits; without fibrils and pores oftener than with them in the upper part of the leaf: the hyaline cells of the leaf-base with large saccate extensions; auricles small.

Fascicles mostly five-branched, the three stouter branches sometimes long and much attenuated to the point, sometimes shorter and abruptly pointed, spreading in very different directions from the stem, *five angled through the distinctly five-ranked arrangement of the leaves*. Retort cells of the branch cortex with slightly recurved neck, and a large aperture at the summit. Branch leaves closely or loosely imbricated, never secund, small, ovate lanceolate, at the usually round-truncate involute-edged and dentate apex bordered by two or three rows of narrow cells. The inner surface in the upper part with very small, isolated, ringed pores, especially in the upper and lower cell-angles; in the broader part of the leaf, near the margins, down to the base with large pores usually without rings. Outer surface from apex to base with numerous pores along the commissures, those near the apex strongly ringed, much larger than in S. Warnstorfii and not round but semicircular; below becoming gradually larger. Near the margins these pores are in part opposite to the inner pores, thereby producing complete perforations; leaves with a plait in the middle of the basal part; hyaline cells with membrane-plaits.

Chlorophyllose cells in cross-section triangular to trapeziform, placed on the inner side of the leaf between the hyaline cells and always free; on the outer side often enclosed by the (here more convex) hyaline cells, or free. Lumen large, triangular; the walls all around equally thick.

Commonly monoicous, more rarely dioicous; ♂ branches short, in the antheridium-bearing part clavate-thickened and always red or violet, after flowering lengthened and attenuate-pointed. Perigonial leaves quite similar to the rest of the branch leaves in form and cell net-work, but nonfibrillose and nonporose in the lower half. Perichætial leaves large, ovate, above drawn out to a longer or shorter, emarginate, involute-edged apex; broadly bordered; in the lower half constructed entirely of long rectangular pitted cells, in the upper part of both kinds of cells; hyaline cells rhombic to rhomboidal, once or several times divided. Fruit not rare; spores fine yellow, quite smooth, 0.021 to 0.025 mm. diam.

Var. *roseum* (JURATZKA.) Tufts with the head now lighter, now darker red or violet-red, the other parts of the plants greenish or whitish.

f. **dasy-homalo-anoclada** WARNST. Tufts very dense; branch-fascicles closely approximate, stronger branches horizontal-spreading and in the upper part of the plant ascending.

New Hampshire, Mt. Lafayette, 3,000 ft. (*Faxon*).

f. **dasy-homalo-drepanoclada** WARNST. Like the preceding form, except that the stronger branches are partly horizontal-spreading and partly falcately bent downward.

N. Hampshire, Mt. Lafayette, 3,500 ft. (*Faxon*).

Var. **viride** WARNST. Plants green or grayish green in the upper part, almost without a trace of red, in the lowest parts generally bleached out.

f. **homaloclada** WARNST. The stouter branches usually all more or less horizontal-spreading.

Vermont, Willoughby Lake, 1,200 ft. (*Faxon*).

S. quinquefarium in the level low country is rare, but in the mountainous regions of northern Europe it is a common moss. When once well understood it may usually be recognized with certainty even under the hand lens. Several graceful forms with curved-spreading branch leaves are carefully to be distinguished from S. Warnstofii which they closely resemble. The form of the stem leaves and the pore structure of the branch leaves in S. quinquefarium, however, are totally different, so that the two species by these alone are easily distinguished from each other. It must certainly be widely diffused in North America.

β. Stem leaves usually in the upper half and even lower down with numerous fibrils and pores, but often also on the same stalk with very few fibrils or none at all; triangular-linguiform with a truncate dentate apex slightly or not at all prolonged. Superficial cells of the stem cortex without pores. Wood cells variously colored, often red, never brown. Branch leaves never five-ranked, appressed, when dry lustreless; mostly monoicous; male branches red.

8. *S. acutifolium* (EHRH. *ex parte*) RUSS. ET WARNST. in Verh. der bot. Ver für Brandenb. Jahrg. 1888, p. 112.

Plants extremely variable in color and habit. In tufts loose or dense, high or low, whitish, green, yellowish-green, or pale-rose to purplish red, or variegated. The individual

plants now weak and slender, now strong and robust like S. Russowii.

Wood cylinder whitish or yellowish-green, very often red, but never brown.

Stem cortex formed of 3 or 4 strata of middling-broad, thin-walled cells; outer walls poreless, inner walls with small pores.

Stem leaves smaller or larger, narrower or wider, the length being, at most, three and one-half times the width of the base. More or less distinctly narrowed from the base upward, often with the edges slightly incurved; isosceles-triangular to triangular-linguiform, with a truncate, dentate, involute-edged, sometimes slightly prolonged point; the broader or narrower border in normally developed plants always much widened downward; hyaline cells in the upper half of the leaf rhomboidal, usually divided by only one transverse wall into two daughter-cells, and on the same plant sometimes with fibrils and with pores on the back, sometimes with neither.

Branch-fascicles consisting of two stouter divergent and one or two weaker pendent branches, sometimes closely approximate, sometimes more distant, according to the drier or wetter stations. Branches long or short, and diverging in very different directions from the stem, *always teretely leaved.* Branch leaves longish-ovate to ovate-lanceolate, with an involute margin at the usually round-truncate and dentate apex, very narrowly bordered, generally closely imbricate, more rarely erect-spreading, *never distinctly five-ranked, never secund, never squarrose; lustreless when dry;* with an inwardly projecting longitudinal plait in the middle base, and with delicate plaits in the membranes of the hyaline cells. Pores on the inner surface in the upper part almost exclusively in the upper and lower cell-angles, small and strong-ringed, in the middle and basal parts most numerous near the edges, large, round and weak-ringed or ringless. On the outer surface with very numerous large pores along the commissures, which toward the base of the leaf become gradually larger and show faint rings; these rings often disappear entirely at the base of the leaf and near its margins, and the pores are situated in the middle of the wall between the fibrils.

Chlorophyllose cells in cross-section triangular to trapeziform, placed on the inner side of the leaf between the here less convex hyaline cells and therefore always free, on the outer side of the leaf either enclosed or partially free.

Monoicous, more rarely dioicous: ♂ branches in the antheridium-bearing part clavate-thickened and red, after flowering attenuated at the tip. Perigonial leaves broader and shorter than the sterile branch leaves, above abruptly contracted to a short, truncate and dentate tip, in the lower half either quite free from fibrils and pores or partly with delicate imperfect fibrils. Perichætial leaves large, ovate, in the lower part usually constructed entirely of elongated, rectangular, pitted, chlorophyllose cells, in the middle and upper part, of both kinds of cells, and in the truncate recurved point entirely of short, narrow-rhomboidal green cells. Hyaline cells often many times divided, but nearly always free from fibrils and pores. Margin with a broad border formed of narrow cells.—Macrospores yellow, papillose, 0.025 to 0.030 mm. diam. Microspores in separate smaller and, when empty, urnshaped capsules on separate plants mixed with the macrosporogonium-bearing fertile tufts, yellow, with 5- and 6-angled polyhedron-faces, 0.012 to 0.013 mm. diam.—Commonly fruiting.

In North America as common as in Europe, and likewise as remarkably rich in forms.

Var. **purpurascens** WARNST. Plants, in the upper part especially in the capitulum, beautiful rose, to purple-red, below paler but without admixture of green.

N. Hampshire, Crawford's, 1,900 ft., Franconia, 1,000 ft.; Mass., Boston, 50 ft., (*Faxon*); Essex Co., 75 ft. (*Scars*).

Var. **versicolor** WARNST. Tufts above, especially in the heads, of very different grades of red, below more or less green, plants sometimes speckled with red and green.

N Hampshire, Crawford's, 1,900 ft.: Franconia, 1,000 to 1,500 ft.; Mass., Mt. Graylock, 1,500 ft., Dedham, 75 ft. (*Faxon*).

f. **robusta**, s. f. **catoclada** WARNST. Plants very stout, mostly in very thickly compressed low tufts, spreading branches long and reflexed directly downward.

Vt., Sutton, 1,000 ft. (*Faxon*).

Var. **flavo-rubellum** WARNST. Plants faint reddish mixed with pale yellow.

N. Hampshire, Crawford's, 1,900 ft. (*Faxon*).

Var. **viride** WARNST. Tufts above light or grayish green or dark green, in the lower parts of the stems faded out.

Mass., Boston, 50 ft., Milton, 500 ft. (*Faxon*).

Var. **pallescens** WARNST. Whole plant whitish, or in the

coma slightly tinged with pale greenish, reddish or yellowish, and below it whitish or faintly greenish; dark green entirely absent.

N. Hampshire, Crawford's, 1,900 ft.; Mass., Boston, 50 ft., (*Faxon*).

f. **dasy-drepanoclada** WARNST. Tufts as well as the branch-fascicles extremely compact, spreading branches comparatively short, slender and usually falcate-recurved.

N. Hampshire, Mt. Washington, 5,000 ft. (*Faxon*).

γ. Stem leaves large, isosceles-triangular, drawn out to a longer or shorter truncate, dentate, involute-edged point. Border broad and much widened downward; hyaline cells usually completely nonfibrillose, rarely with rudimentary fibrils at the apex: many times divided and with membrane-plaits. Wood cylinder variously colored. Branch leaves comparatively large, *glossy when dry*, usually loosely imbricate, often with curved erect spreading to squarrose tips. Generally monoicous, rarely dioicous. Male branches red.

9. *S. subnitens* RUSS. et WARNST. in Verh. d. bot. Ver. für Brandenb. Jahrg. 1888, p. 115.

Syn.: *S. acutifolium*, var. *plumosum* Milde, Bryol. Sil., p. 382 (1869).—var. *luridum* (Hüben.) Aongstr. in litt. ad Gravet (1876).—var. *lætevirens* Braithw. Sphagn. Eur. and N. Am. (1880).—varr. *squarrosulum*, *luridum* (Hüben.), *laxum* Warnst. Eur. Torfm., p. 48-50 (1881)—var. *Schillerianum* Warnst. Flora (1882).—var. *aquaticum* Schlieph. in litt. 1883. Hedw. 1884.—var. *luridum* f. *plumosa*, *violacea*, *lætevirens*, *squarrosula*, *deflexa*, *stricta*, *limosa*, *elongata* Warnst. Sphagnol. Rückbl. Flora 1884.—var. *flavicomans* Card. Rev. Bryol. 1884.

S. plumosum Röll. varr. *submersum* ?, *luridum*, *elongatum*, *lætevirens*, *plumosum*, *violaceum*, *limosum*, *squarrosulum*, *Schillerianum* in Syst. d. Torfm. Flora, 1886.

S. luridum (Hüben.) Warnst. Hedw., 1886, p. 230.

This is among the strongest of the ACUTIFOLIA. *Plants when dry very soft and with more or less of metallic lustre.* Colors quite various, gray, or grass-green, pale yellow-green, yellowish-brown, violet to purple-red, not rarely passing into a dirty green or violet.

Wood cylinder greenish, whitish, violet to dark purple-red.

Stem cortex formed of 3 or 4 strata of cells, and usually on one side of the stem much more strongly developed and with much wider cells; all the cells thin-walled, the superficial rarely with isolated pores, the inner always with small pits. Stem leaves large, elongated, isosceles-triangular, broad at the base, not rarely with undulate margins in the

middle, and above abruptly narrowed into a longer or shorter broad-truncate, dentate and involute-edged point, border broad, much widened downward, and formed of very narrow tubular pitted cells. Hyaline cells in the middle of the base wide and large, above rather shorter, rhomboidal, at the margins narrow, mostly without fibrils and pores, rarely with rudiments of fibrils and pores in the summit of the leaf; all 2 to 6 times divided and with delicate longitudinal plaits in the membrane. The apex sometimes formed only of small vermicular chlorophyllose cells.

Branches 3 or 4 in a fascicle, two stronger, spreading in very different directions from the stem, one or two weaker, pendent and appressed to the stem. Leaves of the stout, spreading branches larger or smaller, densely or loosely imbricate, often curved erect-spreading, seldom somewhat secund or squarrose, never distinctly 5-ranked; from an ovate base narrowed upward to a rather long, dentate, transversely- or roundly-truncate, involute-edged apex. Border 3 to 5 cell-rows in width. A short inwardly-projecting, longitudinal plait in the middle of the leaf above the base. Hyaline cells with numerous fibril-bands; pores on the inner surface almost all near the margins, large, round, often quite ringless and in the middle of the cell walls; in the apex of the leaf the pores are small, isolated in the upper and lower cell angles; pores on the outer surface much more numerous, in the upper $\frac{2}{3}$ to $\frac{3}{4}$ of the leaf large, ringed, semi-elliptic, on the commissures, those that are near the margins being in part opposite the inner pores and thus forming complete perforations of the leaf; pores near the base of the leaf very large without rings and between the fibrils in the middle of the cell-wall. Leaves of the pendent branches in the upper $\frac{3}{4}$ of the inner surface with large round mostly ringless pores in the middle of the cell-walls or in the angles, pores on the outer surface the same as in the other leaves.

Chlorophyllose cells in cross-section isosceles-triangular to isosceles-trapeziform (always the latter in the apex), placed between the hyaline cells on the inner side of the leaf and always free, on the outer side enclosed or free; hyaline cells convex on both sides, but more convex on the outer.

Mostly monoicous, more seldom dioicous: ♂ branches in the antheridium-bearing part reddish-violet, when young short and thick, later lengthened and attenuate at the end. The perigonial leaves not different from the rest of the branch leaves in form and anatomical structure, but near the

base without fibrils and pores or with delicate incomplete fibrils. Perichætial leaves large, ovate, the edge very broadly bordered in the upper part and emarginate at the rounded truncate apex, below formed entirely of long rectangular pitted chlorophyllose cells, from the middle upward of both kinds of cells, the apex of small green cells only. Macrospores yellow, papillose, 0.025 to 0.031 mm. diam. Fruit very common.

This species is distinguished from S. acutifolium, especially *by the peculiar gloss of the branch leaves, and by the stem leaves, which are mostly without fibrils, are protracted into a longer or shorter point, and have their hyaline cells many times divided;* from the larger, stouter forms of S. quinquefarium it recedes by its longer-pointed, not five-ranked branch leaves, and by its differently shaped stem leaves. By the way, it may here be mentioned that S. quinquefarium also occasionally shows a faint lustre in the branch leaves. Incompletely developed forms may easily be mistaken for *S. molle* SULLIV., whose stem leaves, with respect to their shape and their narrow border, have a remote resemblance to those of such immature forms. In this case the distinctive mark is the distantly toothed margin of S. molle in the upper half of the branch leaf, which occurs in no other species of this group.

Var. *flavicomans* CARD Rev. Bryol. 1884, No. 4, p. 55.

Plants very stout, in lax or dense, rather deep tufts, mostly yellowish-brown like S. fuscum. Wood cylinder blood-red; superficial cells of the stem cortex with single pores; stem leaves without fibrils or in the upper part fibrillose. Branch leaves large, longish-ovate, apex broad-truncate and dentate, shining when dry.

Miquelon Island (*Delamarc*). Samml. Europ. Torfm. Serie I, no. 77.

Var. **viride** WARNST. Plants in the upper part gray to grass-green, below bleached out.

Mass., Brookline, 75 feet (*Faxon*).

Var. **obscurum** WARNST. Plants very stout, in high loose tufts. Color in the upper part a mixture of grayish-green and pale, dirty brown; below, brownish. General color a dusky, indefinite brownish green.

Mass., Brookline, 75 feet (*Faxon*).

c. Stem leaves from a narrower base widened upward to the middle and thence produced to a longer or shorter broadly truncate, dentate point; border narrow and of nearly equal breadth from apex

to base; with or without fibrils in the upper part. Wood cylinder always yellowish. Branch leaves loosely imbricated, somewhat shining, the upper margins minutely and remotely dentate; monoicous; male branchlets pale reddish.

10. *S. molle* SULLIV. Musc. Allegh. p. 50 no. 205 (1846).

Syn.: *S. tubulare* Sulliv. Musc. Allegh. p. 49 no. 204 (1846).
S. molluscoides C. Müll. Synops. I. p. 99 (1848).
S. tenerum Sull. et Lesq. Musc. Bor.-Am. I Ed. no. 11 (1856).
S. Mülleri Schpr. Entw.-Gesch. d. Torfm. p. 73, no. 10 (1858).

N. Carolina, Georgia, New Jersey, Alabama, Florida, Louisiana (*Langlois*).

II. Sphagna cuspidata.

A. *Branch leaves porose but always without fibrils.*

a. Pores on the outer side of the leaf rather large, 0.010 to 0.012 mm. diam., elliptic, always in one row in the middle of the cell-wall, 6 to 16 in a cell.

11. *S. macrophyllum* BERNH. MSS. Brid. Bryol. Univ. I. p. 10 no. 8 (1826).

Syn.: *Isocladus macrophyllus* Lindb. in Oefvers.V. Ak. Förh., 19, p. 134 (1862).

New Jersey, Carolina, Louisiana, Mississippi, Alabama, Florida.

This fine characteristic species is placed by Lindberg, together with the next following, in a separate group ISOCLADUS, whilst Cardot includes them in his SPHAGNA MACROPHYLLA. Both seem to me to be in the wrong, for the two species in question, with respect to the form of their stem leaves and branch leaves, and also as to anatomical structure, fit well into the CUSPIDATA. Still another species of this group, *S. sericeum* C. MULL. (Syn.: *S. Hollcanum* Doz. et Mlkb.; *S. seriolum* C. Müll.) from Sumatra also has no fibrils in the leaves and yet there can be no question that it belongs to the CUSPIDATA. Other species of the Cuspidatum group (e. g. *S. Lindbergii* Schpr. and certain acquatic forms of *S. cuspidatum* (Ehrh.) Russ. et Warnst.) also possess uniform or at least nearly uniform branches.

The perichætial leaves of S. macrophyllum become much larger toward the summit of the branch; they are broadly oval, with the margins narrowly bordered; they are formed of the two kinds of cells and run out into a bluntish, denticulate point. The hyaline cells are narrow and long, but to-

wards the apex broader and shorter, and like the stem leaves and branch leaves show no trace of fibrils. On the outside, however, there are round pores in the middle of the cell-wall, which become scarcer toward the apex, and especially prefer the upper angles of the cells. The capsules are small, and when empty of spores urn-shaped, as in S. cuspidatum. The spores are yellow, smooth and 0.030 to 0.035 mm. diam. It is very strange that the male plant still remains quite unknown, and yet it can not be very difficult to find it in the localities where the species fruits. I beg leave, therefore, to earnestly urge all North American bryologists, who are interested in Sphagna, to direct their attention particularly to a search for the male plants of S. macrophyllum. This should be done in the winter months in which, as is known, the Sphagna bloom.

b. Pores on the outer side of the leaf very small, 0.004 to 0.005 mm. diam. in one or two rows in the middle of the cell-wall, 40 to 65 in a cell.

12. *S. Floridanum* (AUST.) CARD. in Rév. des Sphaignes de l'Amerique du Nord (1887).

Syn.: *S. macrophyllum*, var. *Floridanum* Aust. in Bull. Torr. Bot. Club vii, p. 15 (1880).

S. cribrosum Lindb. in Eur. och Nord. Am. Hvit-mossor (1882).

Louisiana *(Langlois)*, Florida *(Austin)*.

Since Austin had previously distinguished this species as S. macrophyllum var. Floridanum it was not justifiable for Lindberg in Hvit-mossor to set up a new name for it, and Cardot was quite right in retaining for the species Austin's name, S. Floridanum.

S. Floridanum stands, with respect to the pore-structure on the outer side of the branch leaves, in a similar relation to S. macrophyllum as *S. obtusum* WARNST. (1889 non 1877) does to *S. Mendocinum* SULL. ET LESQ. The last two species are likewise chiefly distinguished by the size of the pores on the back of the branch leaves. In S. obtusum these pores are extremely small, always show vanishing contours, and are only made visible by strong staining of the leaves; the pores of S. Mendocinum, on the contrary, are always larger and exhibit clearly defined boundaries. The male flowers as well as the fruit of S. Floridanum are yet unknown!

Neuruppin, Feb. 6, 1890.

Flowers and insects. V.

CHARLES ROBERTSON.

Astragalus Mexicanus A. DC.—The flowers are cream-color, often with a bluish tinge at the tip of the keel. The wings and keel are closely fastened together, so that they must be depressed simultaneously. The rigid banner is folded over the wings and keel, and projects straight forward in front of the calyx tube. This tube measures about 8 mm., and the parts of the flower are so contracted beyond it that after a bee has forced its head in so as to touch the anthers, it still needs a proboscis 10 to 13 mm. long to obtain the sweets. The petals are thus disposed so as to limit the accessibility of the nectar and to restrict the place of pollen-contact to the underside of the bee's head. The stigma only slightly surpasses the anthers and may touch the bee a little in advance of them, but self-pollination may occur in absence of insects.

The flower is adapted to the longest-tongued bees. From its early blooming it is especially exposed to Bombus females and to species of Synhalonia. On three days, April 27, 30, and May 2, I observed the following visitors:

Hymenoptera—*Apidæ:* (1) Bombus separatus Cr. ♀, s., once; (2) B. americanorum F. ♀, s. ab.; (3) B. pennsylvanicus DeG. ♀, s.; (4) Synhalonia speciosa Cr. ♂ ♀, s., ab.; (5) S. atriventris Sm. ♀, s. and c. p., very ab.

Four butterflies were seen sucking, viz.: Papilio asterias, Colias philodice, Nisoniades icelus and N. juvenalis, but they are mere intruders, since they steal the honey without forcing down the keel.

Strophostyles angulosa Ell.[1]—The keel is bent strongly to the right and curves around so that its tip stands over its base. The base is large and sack-like and is produced above into a ridge which opposes the passage to the nectary. The left wing is turned to the right, so that the bee is required to alight upon the right side, and she enters the flower between the tip and the basal process of the keel. Seizing this process with her front feet, the bee pulls the keel downward and backward, whereupon the stigma and the pollen-laden brush of the style sweep out over her thorax. In this way the stigma receives pollen already deposited by an-

[1] This flower is described by Foerste in Am. Nat. XIX. 887, 888, figs. 1-5. I did not see a bee depress the keel in the way described by him.

other flower, and the style-brush leaves a new load. As soon as the bee lets go her hold upon the basal process, the keel returns to its place against the banner, and the style draws back into it.

Visitors: Hymenoptera—*Apidæ:* (1) Megachile brevis Say ♀, s. and c. p.; (2) M. exilis Cr. ♂, s.

Extranuptial nectaries.[2]—The following insects were taken while obtaining nectar from these structures:

Hymenoptera—*Andrenidæ:* (1) Augochlora pura Say; (2) Halictus flavipes F.; (3) H. confusus Sm. *Vespidæ:* (4) Vespa germanica F.; (5) Polistes pallipes St. Farg. *Eumenidæ:* (6) Odynerus pedestris Sauss. *Crabronidæ:* (7) Oxybelus 4-notatus Say. *Philanthidæ:* (8) Philanthus punctatus Say; (9) Cerceris clypeata Dahlb.; (10) C. kennicottii Cr.: (11) C. finitima Cr. *Larridæ:* (12) Larra acuta Patton. *Sphecidæ:* (13) Pelopocus cementarius Dru.; (14) Chalybion cæruleum L. *Pompilidæ:* (15) Agenia longula Cr. *Mutillidæ:* (16) Sphærophthalma macra Cr. *Formicidæ:* (17) A black species not abundant enough to interfere with other insects or to suggest a thought of myrmecophilism. *Chrysididæ:* (18) Hedychridium dimidiatum Say. *Braconidæ:* (19) Apanteles sp.; (20) Microdus sp.

Diptera—*Syrphidæ:* (21) Mesograpta marginata Say. *Empidæ:* (22) Empis sp. *Tachinidæ:* (23) Eggeria? sp. *Sarcophagidæ:* (24–25) Sarcophaga spp. *Muscidæ:* (26) Lucilia cornicina F. *Anthomyidæ:* (27) Anthomyia sp. *Ortalidæ:* (28) Camptoneura picta F.; (29) Rivellia quadrifasciata Macq. *Geomyzidæ:* (30) sp. *Drosophilidæ:* (31–32) spp.

Hemiptera—*Capsidæ:* (33) Lygus pratensis L.

Amphicarpæa Pitcheri[3] Torr. & Gray.—The pale blue flowers are approximated in a rather close raceme, so that the attractive function is performed by the inflorescence and does not depend especially upon the banner, as in solitary flowers. For the same reason the wings and keel are relieved of their special office of affording a landing-place for the bees to settle upon. Accordingly, these insects alight upon the flower-cluster and crawl from one flower to another. The calyx-tube is very long (6 mm.), which makes the nectar inaccessible to short-tongued visitors. The petals, also, being freed from their original functions by the flower-cluster, are disposed so as to make the nectar still more

[2] For a resume of the subject of extranuptial nectaries and for reference to the literature see Trelease: Myrmecophilism, Psyche Feb.-March, 1889, 171–180.

[3] On the fertilization of A. monoica, see Meehan: Proc. Acad. Nat. Sci. Phila., 1887, 323–325.

inconvenient for short tongues and to limit the place of pollen-contact to the underside of the visitor's head. The broad banner is folded over the other parts and is held tightly by the calyx-tube, so that with the closely approximated wings and keel it makes it difficult for a visitor with a proboscis shorter than 11 mm. to reach the nectar.

The flower is visited for nectar by *Bombus americanorum* F. ♂ ♀, and by the ruby-throated humming bird, *Trochilus colubris* L.

Cercis Canadensis L.—The red-purple flowers cover the trees before their own leaves and those of other trees appear. The trees can then be seen for miles and must attract bees from afar. The stamens are distinct and not firmly enclosed by the petals, and the calyx is broad and shallow. Accordingly, both honey and pollen are accessible to small and little specialized bees, like Halictus.

Although one of the least specialized of Leguminosæ, Cercis shows one of the most peculiar sets of visitors—the effect of early blooming. Of the bees with abdominal pollen-brushes, which are very fond of flowers of Papilionaceæ, Osmia, which flies in early spring, is abundant, while Megachile, which flies in summer, is absent. Later blooming species are visited by Megachile, while Osmia is absent. Cercis also resembles early flowers by being visited only by females of Bombus, while many flowers blooming in summer are visited by the males and workers. Synhalonia, and Anthophora also as far as I have observed, is only found on early flowers. If Cercis bloomed in summer, I should expect also to find Sphecidæ among its guests, as in the cases of Amorpha and Petalostemon. The flower is further remarkable for being abundantly visited by Colletes, C. inæqualis being more common on it than on any other flower known to me.

On six days, between April 21 and May 5, I captured the following visitors:

Hymenoptera—*Apidæ:* (1) Apis mellifica L. ☿, s. and c. p., ab.; (2) Bombus virginicus Oliv. ♀, s.; (3) B. separatus Cr. ♀, s. and c. p.; (4) B. vagans Sm. ♀, s.; (5) B. americanorum F. ♀, s., ab.; (6) B. pennsylvanicus DeG. ♀, s., ab.; (7) Anthophora ursina Cr. ♂ ♀, s., freq.; (8) Synhalonia speciosa Cr. ♂ ♀, s. and c. p., ab.; (9) S. honesta Cr. ♂, s.; (10) Ceratina dupla Say ♂, s.; (11) Osmia lignaria Say ♂ ♀, s. and c. p.; (12) O. atriventris Cr. ♀, s. and c. p.; (13) O. albi-

ventris Cr. ♀, s. and c. p.; (14) O. latitarsis Cr. ♂, s.; (15) Nomada luteola St. Farg. ♂ ♀, s.; (16) N. bisignata Say ♂ ♀, s. *Andrenidæ:* (17–18) Andrena spp. ♀, s. and c. p.; (19) A. hirticeps Sm. ♀, s.; (20) A. valida Say ♀, s. and c. p.; (21) Augochlora labrosa Say ♀, s.; (22) Halictus coriaceus Sm. ♀, s.; (23) H. lerouxii St. Farg. ♀, s. and c. p.; (24) H. flavipes F. ♀, s. and c. p., ab.; (25) H. zephyrus Sm. ♀, s.; (26) H. pilosus Sm. ♀, s. and c. p.; (27) H. confusus Sm. ♀, s. and c. p.; (28) H. stultus Cr. ♀, s. and c. p., ab.; (29) Colletes inæqualis Say ♂ ♀, s. and c. p., ab.; (30) C. canadensis Cr. ? ♀, s. and c. p. *Vespidæ:* (31) Polistes pallipes St. Farg. s.

Diptera—*Bombylidæ:* (32) Bombylius fratellus Wied., s. *Empidæ:* (33) Empis sp., s.

Lepidoptera—*Rhopalocera:* (34) Lycæna comyntas Godt.; (35) Nisoniades icelus Lintn., both s.

Coleoptera—*Cerambycidæ:* (36) Molorchus bimaculatus Say.

Cassia Chamaecrista L.[1]—The sickle-shaped pistil is turned either to the right or to the left, holding the stigma in such a position that it touches the bee upon the side; the flower is therefore an example of what Delpino calls a *pleurotribe* flower. Ten long black anthers with terminal pores turn in an opposite direction from the pistil. The petals are bright yellow, the upper ones are provided with a little red at base which serves as a path-finder, but not as a nectar-guide, since nectar is wanting. All are widely expanded and flexible except the lateral one toward which the anthers turn, which is erect and strongly incurved and so stiff that it commonly breaks on being bent back.

The flowers are visited exclusively by bumble-bee females and workers in search of pollen. Landing upon the anthers they seize them between their mandibles and stroke them downwards with a sort of milking motion. The pollen being thus forced out of the terminal anther-pores falls either directly upon the bee or upon the lateral petal which is pressed close against the bee's side. In this way the side of the bee which is next to the incurved petal receives the most pollen. Both right and left-hand flowers are found upon the same plant. A bee visiting a left-hand flower receives pollen upon the right side and then flying to a right-hand flower, strikes the same side against the stigma.

[1] See J. E. Todd. On the flowers of Solanum rostratum and Cassia Chamæcrista, Am. Nat. XVI, 281-287. fig. 2.

Visitors: *Apidae*: (1) Bombus virginicus Oliv. ☿; (2) B. separatus Cr. ☿: (3) B. americanorum F. ♀ ☿; (4) B. scutellaris Cr. ☿—all c. p. Megachile brevis Say ♀ mutilates the petals by cutting out large circular pieces to use in her nest

Extranuptial nectaries.—The extrafloral nectaries of this plant and of C. Marilandica are situated on the upper side and near the base of the petioles, being cupuliform in Chamæcrista and club-shaped in Marilandica.

Visitors: (Aug. 2, 7, 8) Hymenoptera—*Andrenidæ*: (1) Halictus confusus Sm. *Eumenidæ*: (2) Odynerus foraminatus Sauss. *Larridæ*; (3) Larra argentata Beauv. *Sphecidæ*: (4) Pelopocus cementarius Dru.; (5) Chalybion cæruleum L. *Pompilidæ*: (6) Pompilus sp.; (7) P. navus Cr.; (8) Priocnemis fulvicornis Cr. *Scoliadæ*: (9) Tiphia inornata Say. *Mutillidæ*: (10) Mutilla hexagona Say; (11) M. sayi Blake; (12) Sphærophthalma macra Cr. *Formicidæ*: (13, 14) A black and a large red species. *Chrysididæ*: (15) Holopyga ventralis Say; (16) Chrysis montana Aaron. *Braconidæ*: (17) Apanteles sp.

Diptera—*Tabanidæ*: (18) Tabanus lineola F. *Syrphidæ*: (19) Mesograpta marginata Say: (20) M. polita Say. *Tachinidæ*: (21) sp.; (22) Phorocera sp. *Sarcophagidæ*: (23) Sarcophaga sp. *Muscidæ*: (24) Lucilia cornicina F. *Anthomyidæ*: (25) Anthomyia sp. *Ortalidæ*: (26) Rivellia quadrifasciata Macq

Hemiptera—*Capsidæ*: (27) Lygus pratensis L.

Lepidoptera—*Rhopalocera*: (28) Callidryas eubule L. (Trelease notes.)

Cassia Marilandica[5] L.—Three petals form an upper lip, while two form a lower, all of them being entirely yellow. Fritz Müller[6] mentions several flowers in which there are two kinds of stamens with different functions. In this flower there are three sets of stamens, all with different functions. The three upper are reduced to dark scale-like rudiments, which serve as pathfinders. Accordingly, the red spots which occur on the upper petals of Chamæcrista are wanting in Marilandica. Four short stamens furnish pollen for the visitors. Bumble-bees milk the pollen out of these, using their jaws as in the case of Chamæcrista. Two long stamens, one on each side of the style, furnish pollen for cross-fertilization.

[5] See Meehan: Proc. Acad. Sci. Phil., 1886, 314-318. Also Torr. Bull. XIII, 249. Figures of the stamens and style of C. occidentalis and of the flower of C. acutifolia by Todd, in Am. Nat. XVI, 285, represent C. Marilandica fairly well.

[6] Nature XVII, 364.

They have inflated anthers, which probably have a bellows-like action like the long stamen of Solanum rostratum[7] and the anthers of Rhexia Virginica.[8] Between the style and a long stamen is another long stamen with an anther like those of the short stamens. Bees, no doubt, force the pollen out of this as they do from the short stamens. The style is turned sometimes to the right, sometimes to the left, and the flower itself is turned slightly to one side or the other, so that the stigma touches the side of the visitor, making the flower *pleurotribe*. According to Meehan, the flowers fail to produce seed under a net. Both he and Leggett saw bumble-bees collecting the pollen. I have seen the flower visited for pollen by Bombus americanorum F. ♀.

Extranuptial nectaries.—Visitors: (on one occasion) A large red ant; Sarcophaga sp.; Anthomyia sp.; Camptoneura picta F. (Ortalidæ); Coccinella sanguinea L.

Carlinville, Ill.

Fermentation of bread.[1]

KATHERINE E. GOLDEN.

Ferments have been known since very early times, for we have accounts of the early Egyptians using leaven to increase the lightness of bread. Much has been written and said in a superficial way about the fermentation of bread, and there are many methods of preparing and preserving leaven for bread-making given in old books, but what was in the leaven that produced the fermentation long remained an unsolved problem. Then came the early researches into the subject which established the now well-known facts that yeast causes carbon-dioxide and alcohol to be generated from sugar, that the carbon-dioxide causes the bread to rise, and that the alcohol is driven out of the bread by the heat in baking. The processes that the yeast and sugar underwent in causing the decomposition of the latter were not at that time understood, nor whether there were other organisms besides the yeast present.

Of late years, however, since bacteriology has received the attention of scientific men, the old view that yeast alone

[7] Todd: l. c. [8] Torr. Bull. V III. 102-104.

[1] Part of a thesis presented to the faculty of Purdue University for the bachelor's degree, based upon work done in the botanical laboratory under the direction of Dr. J. C Arthur.

causes bread to rise has been questioned somewhat, some still claiming that it does, others that it has nothing whatever to do with the rising, while still others take a halfway course, that is, that yeast and bacteria acting together do the work.

Chicandard,[2] in 1883, presented a paper before the French Academy of Sciences in which he explained the fermentation of bread to be the result, not of yeast, but of a special bacillus that develops normally in the dough, while the yeast only hastens the development. He claims that the most essential part of the fermentation is the transformation of a part of the insoluble albuminoids into soluble ones.

Laurent,[3] writing four years later, presents the same idea in regard to the cause of the fermentation. He found in dough a bacterium, Bacillus panificans, as he calls it, that occurs in short and long rods and forms sharply defined yellow colonies on plate-cultures. It can stand a high degree of heat, so high that the rods are said to be still alive under the crust of the bread. The spores will stand long heating at boiling temperature. Laurent says that this bacillus is responsible for the formation of carbon-dioxide, besides a certain amount of lactic, butyric and acetic acids. In the warm season this bacillus sometimes causes the bread to become slimy, so that it can be drawn out into threads. In such bread are found myriads of the organisms which change the starch into erythrodextrin, and thus bring about the slimy metamorphosis.

Wigand[4] agrees in substance with the preceding views in regard to bread fermentation, but he says that the bacillus is formed spontaneously from the albumen of the gluten, for although an eminent scientist and writing but six years ago, he believed in the now generally discarded theory of spontaneous generation.

And lastly, Marcano[5] believes that the motile bacteria found in dough are the true cause of the fermentation.

Opposed to the view that bacteria are the cause of the rising of bread, we have the opinions of such men as Birnbaum, Arcangeli and Dünnenberger. Birnbaum[6] thinks that

[2] Chicandard, Comptes rend, 1883, p. 1585; quoted by Dünnenberger, l. c. and Peters l. c.

[3] Laurent, E. Bull. Acad. Roy. Sci. Belg., Vol. X, 1885, p. 765; Bull. Soc. Roy. Bot. Belg., Vol. XXV., pt. 2 p. 165; abstract in Centralb. f. Bak. u. Parasitenk., Vol. I, 1887, p. 504; Just's Bot. Jahresb., Vol. XIV, pt. 1, 1886, pp. 396, 397.

[4] Wigand, Entstehung und Fermentwirkung der Bakterien, 2d Ed., 1884, p. 11.

[5] Marcano, Compt. rend., xcvi, xcvii, 1883; quoted by Dünnenberger, l. c.

[6] Birnbaum, Lehrbuch der landwirtschaftlichen Gewerbe, 1866, Vol. I. p. 228; quoted by Dünnenberger, l. c.

the action of leaven is due solely to the presence in it of common or alcoholic yeast. Arcangeli[7] also thinks yeast is the cause of the fermentation. In every instance he found a bacterium, the common Bacillus subtilis, but he says this is of very little concern except in facilitating the solution of the albuminous bodies. Dünnenberger[8] goes even farther than this, for he claims the bacteria found in bread are a pollution and entirely dispensable.

Then come the views of Boutroux, Flügge and Peters which disagree with those just stated, that is, that yeast alone or bacteria alone are the cause of the rising of the bread. They found other organisms besides the yeast in the dough, and they claim that these organisms assist in the rising. Boutroux[9] thinks that both yeast and bacteria assist in the fermentation, while Flügge[10] thinks that the bacteria may help in the fermentation since they are found in leaven in overwhelming quantities. Peters[11] has studied leaven more particularly. He found five different bacteria in it that had more or less resemblance to one another. He holds that common yeast causes the alcoholic fermentation and bacteria the acid fermentation. But he thinks the bacteria are of secondary importance.

There are many points of difference in the opinions just cited, and at first thought it seems rather unaccountable that men who worked with scientific precision, as these men undoubtedly did, should arrive at such different results. The differences can doubtless be accounted for, however, if we take into consideration the fact that they worked under different conditions and probably looked at the subject from different standpoints, for though it is presumable from their writings that nearly all of them used leaven, it was very probably obtained by somewhat different methods and under different conditions.

Leaven is dough left over from one baking to another, either with or without the addition of an extract of hops or malt. This is the kind of ferment that is generally used in the old countries. In this country in places distant from

[7] Arcangeli, G. Atti. Soc. Toscano Sci. Nat., Vol. IX, 1888, p. 22; abstract in Centralb. f. Bak. u. Parasitenk., 1888, Vol. III, p. 717.

[8] Dünnenberger, C. Bot. Centralb., Vol. XXXIII 1888, p. 245; Archiv der Pharmacie, Vol XXVI, 1888, p. 546; abstract in BOT. GAZETTE, Vol. XIII, 1888, p. 140.

[9] Boutroux, Compt. rend., XCVII., 1883; quoted by Dünnenberger, l. c.

[10] Flügge, Die Mikroorganismen, 1886, p. 491.

[11] Peters, W. L. Die Organismen des Sauerteigs und ihre Bedeutung für die Brotgährung, Inaug.-Diss., 1889; Bot. Zeit., XLVII., 1889, p. 405; abstract in Jour. Roy. Micr. Soc., 1890, p. 75.

markets a ferment is made from potatoes, boiled and mashed, with flour, salt, sugar, the water that the potatoes have been boiled in, and yeast. There are various other methods of making this ferment, but they do not differ essentially from one another. This is sometimes called emptyings, or jug-yeast, and is semi-liquid, so that it differs very materially from the leaven of the old country. Of course, in towns and cities where a fresh supply of yeast can be obtained readily no such methods need be resorted to. Besides the ferments mentioned there are also the dry yeast cakes, that is, yeast mixed with corn-meal, and dried, which will vegetate when moistened, and the salt-rising where no ferment is added, the fermentation being supposed to be set up by the organisms that are already in the ingredients.

The experiments which I performed in order to determine whether the yeast or the bacteria are more instrumental in causing bread to rise do not solve the question by any means, still they give some additional information on the subject. Freshly made dough that had been fermented with Vienna pressed yeast, commonly called German yeast, and sold under the name of Fleischmann's Compressed Yeast, was examined with the microscope and the yeast found to be Saccharomyces cerevisiæ, and with it a bacterium having the characteristics of Bacillus subtilis. These two germs were separated from each other by means of gelatine plate-cultures. A single colony of each was placed in flasks in equal quantities of a nutrient solution made according to directions given by Dr. Stone,[12] the proportions being 25 grams German yeast to 125 cubic centimetres distilled water, with 10 per cent. sugar, boiled thoroughly, filtered, and sterilized for three successive days. The flasks containing the yeast and bacteria were then placed in a vegetation chamber, kept at about 84-86° F. (29-30° C.), this being the optimum temperature for Bacillus subtilis, that of yeast being about 92° F. (33° C.). After vegetating for two and one-half months they were tested for the amount of carbon-dioxide given off by each, the gas that had accumulated in the flasks being first drawn off. The yeast gave off 23 mg. gas in one hour, the bacteria 70 mg. in the same time. A second test was made of a four days' growth of each, the germs for these growths being obtained from agar cultures of each, inoculated from the original plate cultures. The yeast gave off 50 mg., the bacteria 60 mg. in an hour. In a case where

[12] Stone, W. E., BOT. GAZETTE, 1887, p. 270.

the sponges, made as will be shortly stated, and still in the flasks, were tested instead of the inoculated fluids for the carbon-dioxide, the yeast gave 90 mg. in an hour, the bacteria only 10 mg. in the same time.

After each test a bread sponge was made from both kinds, that is 200 grams sterilized flour was put into a flask and with the flour a nutrient solution, consisting of 150 c.c. potato-broth, 2 grams salt, and 8 grams sugar. The bread sponges were then placed in a vegetation chamber and kept at uniform temperature of 84–86° F. (29–30° C.), for about twenty-four hours. At the end of that time the yeast sponge had run well and uniformly, but the bacteria sponge invariably showed a separation of the flour from the liquid, the flour going to the bottom of the flask, and a layer of clear liquid remaining on the surface.

The sponges then had more flour added to them, and the dough thus formed was kneaded thoroughly, and again placed in the vegetation chamber to rise, about twenty-four hours being allowed for this: a second kneading was then done, the time allowed for rising being about the same as after the first kneading. The yeast dough rose higher than the other in every case, but in the kneading felt like bread with shortening in it, lacking the tough, elastic qualities of good dough. The bacteria dough, though not risen so high, felt more like the ordinary dough, being more elastic, tougher, and smelling somewhat sweeter, though it, too, felt as if it contained some shortening.

The dough when placed in the baking-pans was allowed to rise for about six hours before transferring to the oven. It was then baked at a temperature of 280–350° F. (138–176° C).

The yeast bread in every case showed a greater degree of lightness, as indicated by its bulk, than the other, but was coarse in texture, being filled with numerous large cavities. The bacteria bread, though apparently not so well risen, had a finer texture, with but the occasional occurrence of large cavities.

The sterilized flour used in all the experiments was prepared by first drying it in an oven two or more hours a day for four to six days, the oven being kept at a temperature of 150–220° F. (66–105° C.). The oven was then raised to 250–300° F. (121–149° C.), for an hour and the sterilization completed.

The utensils used were in all cases sterilized by heat,

and the hands of the operator washed in corrosive sublimate, but perfectly pure cultures were not obtained in any instance.

Though the cultures were not perfectly pure, they had such a very small amount of impurities in them that the results were almost or quite the same as would very probably be obtained from pure cultures.

The inferences drawn from these experiments are that both yeast (Saccharomyces cerevisiæ) and bacteria (Bacillus subtilis?) separately generate carbon-dioxide in sufficient quantities to raise bread. The amount of gas generated is presumably in direct proportion to the growth of the organisms and the viscosity of the surrounding medium. From the fact that the bacteria-inoculated fluid gave off more carbon-dioxide than the yeast fluid, while the bacteria sponge gave off less than the yeast sponge, it would indicate that the growth of yeast was less in the fluid than the growth of bacteria, but greater in the sponge, as the sponges in both cases were most probably of equal viscosity, as the conditions were as nearly as possible the same in both.

It was demonstrated by the experiments that both yeast and bacteria can separately raise bread, and, under the conditions of the experiments, the yeast somewhat better than the bacteria. Now, whether or not they act together in raising bread ordinarily was not demonstrated, but from the fact that both organisms were found in large quantities in dough that had been raised by Fleischmann's yeast, and that bacteria are always in the air and in large quantities on the surface of the grain from which flour is made, and also that they occur in all preparations of yeast ferment, it seems to be the only satisfactory conclusion that both the bacteria and the yeast act together in raising most if not all kinds of bread.

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BRIEFER ARTICLES.

Some effects of the mild winter.—The mild weather during the past winter caused so many remarkable changes in the usual habits of plants, in this locality, that I can not forbear offering a few notes for publication. Malva rotundifolia, Stellaria media, Alyssum maritimum, Capsella Bursa-pastoris, Bellis perennis, and Lamium amplexicaule, continued in bloom all winter, except about the first three weeks of March, during which time it was so cold as to stop vegetable growth. The cold spell

however broke up with a warm rain, and so much of the advanced vegetation went on growing from the stage where it had been checked.

Many of the flowers of Malva rotundifolia and Lamium amplexicaule went through the stages of anthesis without opening. Since warm weather has set in these flowers have lost their cleistogamous character. Poa annua remained green and in panicles all winter. Cydonia Japonica was in a blaze on New Year's day, and continued to bear flowers until May 10. January 2 I found scattering blossoms on the common peach, but it did not bloom fully until April 15. Forsythia suspensa bore flowers from January 1 to April 11. Spiræa hypericifolia was in bloom from January 6 to the end of April. January 5, Acer dasycarpum, and January 19, Acer rubrum began to show flowers. They were in full bloom, or fruiting, when the cold snap of March came, the result being that nearly all their fruit was killed. Lindera Benzoin began blooming and leafing very early in January, most of the fruit and many of the trees being destroyed by the March freeze. In those instances where the bark and sap were frozen, the bark became dry and cracked as if the shrub had been burned.

Viola tricolor and the var. arvensis have been in bloom, in gardens and fields, since January 6.

Syringa vulgaris began sending out leaves February 4, but all the leaves and the half opened flower clusters were killed during the first half of March. Very few, if any, of these species produced mature flowers here.

The daffodil and spring crocus were in bloom from February 1 to the second week in May.

Ulmus fulva was in bloom February 10, and Ulmus Americana, February 13, but they, like the maples, lost nearly all their fruit during the first half of March.

Vinca minor was found in bloom February 13; Ranunculus abortivus and Muscari botryoides, February 20, and Hyacinthus orientalis, February 25; they were checked during the frosty days in March. It was later than usual when they finally were through blooming.

During February the buds of Acer saccharinum and of the var. nigrum were well advanced, but did not come to flowering; many of these buds were frozen during March, so that very few trees bore flowers in May—not more than one tree in thirty. But the interesting fact was noted, that of the trees which did bear flowers nearly all were nigrum. This would appear to indicate that the variety is better suited to withstand severe exposure, than the species, while in an advanced stage of æstivation; due probably to the extra protection afforded by the down on the bud. The diagnostic points of the leaves and fruit, given by some authors as existing between the species and the variety, do not hold good in this locality. The only constant distinguishing sign being the downy petiole and buds. Probably more time and favoring condi-

tions may yet make this a distinct species. The variety is far less abundant, in this vicinity, than the true species.

I have cultivated, for a number of years, a bed of Melilotus officinalis, and another of Datura meteloides. During all these years they behaved as annuals, but this spring they came up in abundance from last year's roots, and also from the scattered seeds.

I have been much interested in noting the progress Phoradendron flavescens has made during the past two mild winters. It is found in much greater abundance and in larger bunches than I have yet seen it in this vicinty. A few more mild winters and it would extend its range northward several hundred miles. During the past twenty years, on several occasions, it has been almost entirely exterminated by cold winters.

In addition to the hosts given (BOTANICAL GAZETTE ix. 102), for this locality, I can now add Prunus serotina.—JACOB SCHNECK, *Mt. Carmel, Illinois.*

A new Helianthemum.—Mrs. S. B. Walker, of Castle Rock, Colorado, has for two successive seasons sent specimens of a Helianthemum which ought to be characterized as a good variety of H. Canadense, as follows:

H. Canadense, var. **Walkeræ.** Leaves narrowly obovate to linear-oblong, 12 to 36 mm. long: petal-bearing flowers 1 to 5, on pedicels 6 to 8 mm. long: petals obovate, obcordate or cuneate, 6 to 8 mm. long, bright yellow, varying to paler: secondary flowers apparently wanting: capsule 4 to 6 mm. long.—Douglas County, Colorado, 1889 and 1890. *Mrs. S. B. Walker.*

The resemblance to H. Canadense is quite well marked, but that species is not given as occurring west of Minnesota, while our variety occurs in a region hitherto said to be without a representative of the genus. The specimens are excellent, and collected at various times, yet none of them show any secondary flowers so characteristic of the species. This character together with the leaves and more numerous petal-bearing flowers, make a sufficiently marked variety.—WALTER H. EVANS, *Crawfordsville, Ind.*

Penicillium and corrosive sublimate.—Dr. Coulter, on the above topic, in the March number of the GAZETTE, relates an experience that is similar to one we have had with our glue bottles in the laboratory. By protracted sterilization of bottle and addition of a considerable quantity of a saturated solution of mercuric chloride, the growth of the fungus was stopped. As neither of these results were determined quantitatively, an experiment was tried with percentage solutions, to see how much mercuric chloride was necessary to stop the growth of the fungus. 10 c. c. tubes of gelatine, to which were added 1, 2 and 3 c. c. of a solution of mercuric chloride (1:1000) were copiously inoculated with Penicillium glaucum and then plated out according to the usual bacteriological

methods. No. 1, in which the mercury was in the proportion of 1 : 10000, showed at the end of ten days five colonies of the fungus. Nos. 2 and 3, in which the mercury was in the proportion of 1 : 6000 and 1 : 4500, respectively, failed to give any growth. Gelatine affords a good medium for the growth of this fungus, and one also can distribute the fungicide much more thoroughly than can be done in a permanently solid mixture. When grown on solid media a much larger proportion of the poison is necessary, as it is impossible to distribute it as thoroughly as in fluid cultures. A quantity of starch paste was made, to which was added corrosive sublimate, in exact proportion of 1 : 1000. This was done before boiling the starch solution, in order to distribute as thoroughly as possible the mercury. Of three cultures made from this starch paste, two at the end of six days showed considerable growth of the fungus, about the inoculation point. This seems to indicate that it is on account of the density of the medium, and consequent insufficient distribution of the poison, that the fungus is able to grow. When grown in proper media, in which the poison can be thoroughly and equally distributed, Penicillium is unable to stand the presence of germicides to a greater extent than many other forms.—H. L. RUSSELL, *Botanical Laboratory University of Wisconsin.*

CURRENT LITERATURE.

Hackel's Gramineae.

American literature has received an invaluable increase in the translation of a work so important as that of Prof. Hackel,[1] not only in regard to its scientific merits, but also as being of practical use to the farmers and students in the United States. Among all the works hitherto published upon this subject, Prof. Hackel's book ranks as undoubtedly the most comprehensive, and the translators have rendered a great help to the study of this family, the grasses, in our country.

We are therefore greatly indebted to the translators for having made such a work more accessible to American students and farmers, and the translation has been done in a manner that makes it not only pleasant reading, but also interesting to scientific students and easily understood in practical use.

The work, as it presents itself, is divided into two parts, of which the first contains general remarks upon the structure, morphology and physiology, while the second part includes keys of analysis and descriptions of the tribes and genera. We find, for instance, in the first part all the modern views in regard to the correct understanding of the structure of

[1] The True Grasses, by Edward Hackel, translated from Die natürlichen Pflanzenfamilien (Engler and Prantl) by F. Lamson-Scribner and Effie A. Southworth. (Henry Holt & Co., New York, 1890.)

the grass-flower, an explanation of the different organs, the glumes, the palet, the lodicles, etc.; furthermore the structure of the seed with the embryo, and a very complete description of the germination itself. This is so much more important, as the translators thereby have defined several botanical terms in a clear and concise manner, at least so that several of these are easily to be used also in descriptions of other families. The second part contains the more systematic treatment of the genera, preceded by a key to the tribes. Diagnoses have also been given to not less than 313 genera, which is an increase of fifteen genera over the number recorded by Bentham and Hooker. It is also a good improvement, made by the translators, that the respective number of each genus in Bentham and Hooker's Genera Plantarum has been inserted in parenthesis before the generic names, which facilitates ready reference to that work and at the same time shows the diversity between the systems of classification adopted.

It is also to be remarked, that a number of notes and observations have been added to the translation by Profs. Hackel and Scribner, so that it is even more complete than the original work. The book contains numerous good figures, most of which have been obtained from older authors, as for instance, Gray, Kunth, Nees v. Esenbeck, Trinius, and others.

But while an attempt has been made, as it seems successfully, in regard to the identification of the genera of the grasses in a more complete stage with the flowers developed, then the next stage should be to teach how to distinguish them before the blooming, by characters taken for instance from the leaves or rhizomes. Several attempts have already been made in this line by European botanists, and with great success, so that it has been proved that in many cases the leaf alone is sufficient, when the question is to distinguish a genus or even a species. This would be a great help to the farmers and field botanists, but at the same time of great interest to descriptive botany, in adding structural characters to the diagnoses.

It is far from difficult to find characters of this kind, if we look at the differences in the venation of the leaf, the form of the blade, the ligule, the sheath, whether open or closed, which show a large variation even in the same genus. And the internal structure of the leaf, examined by a low power of the microscope, will undoubtedly show many differences. —THEO. HOLM, *U. S. National Museum*.

A new school text-book.

Does the frequent appearance of new text-books show that there is still a want, "long felt," yet not "met"? or does it merely indicate that another live teacher has a plan of his own which he thinks others may find useful? Dr. Campbell's Structural and Systematic Botany[2] is offered

[2]CAMPBELL, DOUGLAS HOUGHTON.—Elements of Structural and Systematic Botany, for High Schools and elementary college courses. Pp. ix. 253. Ginn & Co., Boston, 1890.

now as "an introduction to the study of botany, for use in high schools especially, but sufficiently comprehensive to serve also as a beginning book in most colleges." It comes also as "a strong protest against the only too prevalent idea that the chief aim of botany is the ability to run down a plant by means of an 'analytical key,' the subject being exhausted as soon as the name of the plant is discovered." With which protest we are in complete sympathy. Fortunately we have begun to see the decay of this notion of the province of botany and its destruction from this time will be rapid.

We must doubt, however, whether it is not better for beginners to get a conception first as to the gross anatomy of the flowering plants. The only objection that can be urged against beginning in "the good old way" is that false notions of the relations of the flowering plants and their structures are likely to be obtained, which will be difficult to eradicate. Any teacher, however, who is capable of using the book before us will be capable of imparting correct notions of the phanerogams. Herein lies the chief difficulty as far as teaching botany is concerned—the trouble is not so much with the books as it is with the teachers. Few will be found except in the high schools of the largest cities who are competent to use the book now offered to them. If they are competent we fear that the time required for its completion will prove a bar. It must be conceded that this book can only be used by a teacher well-trained in general morphology and histology, and with command of at least a year of the pupil's time for two hours daily—conditions hardly to be expected in our high schools and too seldom attained in our colleges.

Moreover the book deals so much with classification that at times it almost degenerates into a catalogue of orders with their characters. If these parts are to be memorized they are too voluminous. If they are for reference only they are far too condensed. In general its plan is the same as that of Bessey's Essentials of Botany, lacking the introductory part of that and having a fuller account of individual representatives of some groups. (It may be mentioned here as curious that neither of Bessey's works is mentioned among the useful reference books.)

Although we do not coincide with the author as to the wisdom of his plan, it must be said that Dr. Campbell has had a clear and definite plan and has executed it well. The illustrations are nearly all new, well drawn, well engraved and suitable to the page. A few are too sketchy—so much so as to give a poor idea of the structure represented. The publisher's work is in every way excellent.

OPEN LETTERS.

A cheap and excellent plant press.

A board with weights is a good press except where one moves around upon his collecting tours. In this case something more portable is desired. I discard as clumsy all presses formed of wood. Several forms are advertised, yet I have seen none that meet the requirements for lightness, strength and portability. The common board with weights, while it is most often used, does not permit free circulation of the air, hence specimens dry exceedingly slowly in this way. The press described below is one which any tinner can make, and excels any of the manufactured presses which have come to my notice.

Out of common coppered iron wire three-sixteenths inch in diameter, two rectangles, each twelve by eighteen inches, are made. The tinner then solders a sheet of galvanized wire screen, with about one-fourth inch mesh, upon these frames. The edges of the wire screen should be turned up over the wire. One of these frames, after having the screen soldered on, is taken for the bottom piece, and three pieces of the same kind of wire are soldered at equal distances crosswise on the side of the bottom frame which is not to come in contact with the dryers. At the six points where the ends of these crosspieces are soldered to the frame, pieces of suitable chain are rigidly soldered. On the other frame three pieces which are long enough for each end to project about three-eighths of an inch are soldered. These ends are doubly bent to fit snugly around the wire of the rim and to afford curved hooks upon which the links of the chains attached to the other piece may be hooked. These ends can be bent cold and trued up with the file. For the chain I used dog-chain having links about one inch in length. In this press plants, if exposed to the sun and wind, dry with surprising rapidity, and the resulting specimens possess a freshness and pliability that are not secured with presses of other kinds. The press costs from $1 to $1.50.

I use a similar though much lighter press for a portfolio, attaching a shoulder-strap by means of light snaps upon the ends for carrying. I snap the fastenings over the wire on one of the edges of the bottom piece.

Blackburn University, Carlinville, Ill. WM. E. ANDREWS.

NOTES AND NEWS.

DR. B. D. HALSTED has a very interesting paper on the doubling of flowers in *Popular Science Monthly* for July.

PROFESSOR L. M. UNDERWOOD, of Syracuse University, has been granted a year's leave of absence. He will spend the time chiefly at Cambridge in the prosecution of some special work.

A PRELIMINARY list of the mosses of Staten Island has been published by Mrs. Elizabeth G. Britton. The list represents the collections of eight years, and includes one hundred and one species.

MR. C. R. ORCUTT, of San Diego, California, is making a special study of the *Cactaceæ*, and would be glad to receive living plants or other material from any locality. He desires to cultivate all the varieties possible.

M. HENRI JUMELLE begins, in the last June number of the *Revue général de Botanique*, a capital review of the works on vegetable physiology and chemistry, published between July, 1889, and April, 1890.

MR. EDMUND G. BAKER is doing good service in bringing together information concerning the genera and species of *Malveæ*, in *Jour. Bot.* It is a group that sadly needs monographing, and is an exceedingly perplexing one on our southern borders, which are so largely tinctured with Mexican forms.

THE *Journal of Botany* (July) gives an interesting account of the changes at Kew, and pays a handsome tribute to the services of the three botanists concerned. Professor Oliver, the retiring curator, Mr. J. G. Baker, the new curator, and Mr. Hemsley, who takes Mr. Baker's former position as assistant curator.

BOTANICAL ARTICLES in *Zoe*, for June, are: Heterosporous fern allies of the Pacific coast and Mexico, by Lucien M. Underwood (in which a new Isoetes is described); Brodiæa multiflora, by Carl Purdy; The plants of Santa Catalina Island (with 2 plates), by T. S. Brandgee; Naturalized plants of Southern California, III, by S. B. Parish; Pappus of Microseris, by T. S. Brandegee.

MESSRS. UNDERWOOD & COOK have just issued the seventh and eighth decades of their Hepaticæ Americanæ in the same neat form as previous decades. Only a few sets of the two previous decades are left and the price is now $1.50. The sets of illustrative fungi prepared by the same authors have been sold with the exception of three copies. Sets were mostly purchased by colleges and experiment stations.

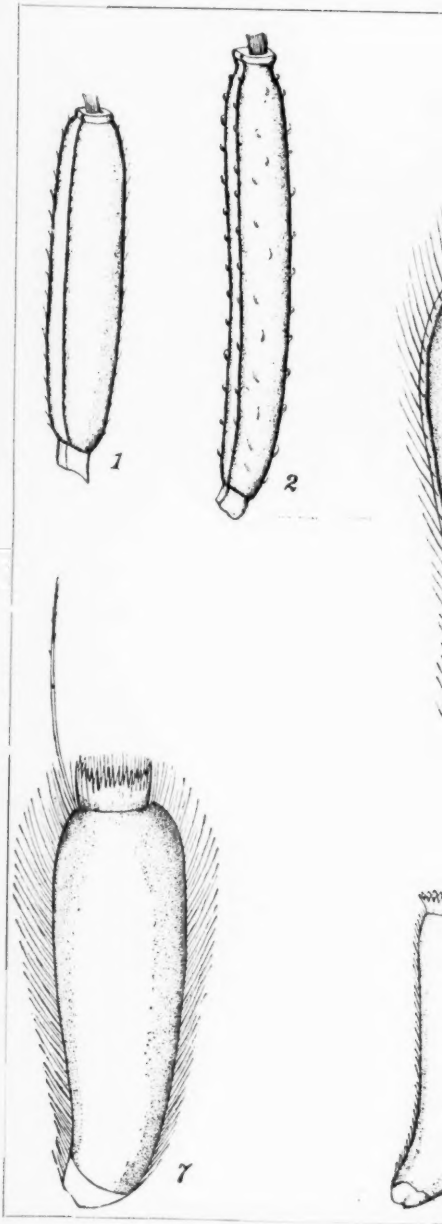
THE DUTCH SOCIETY of Sciences in Harlem has announced a prize of a gold medal or 150 gulden for the solution of the following problems: The role of bacteria in the destruction and formation of the nitrogenous compounds in different sorts of soils; or, the mode in which different parts of plants can unite with each other, and particularly the phenomena of healing which accompany the operations of grafting by scions, buds or contact. The papers may be written in Dutch, German, Latin, *etc.* (which may be supposed to include English), and must be sent to Dr. J. Bosscha, in Harlem, before January 1, 1891.

MR. C. MULLER has recently given special attention to the discrimination of the various forms of collenchyma. He is able to distinguish the following: 1, Collenchyma proper with the thickening chiefly in the corners of the cells; 2, Bast collenchyma, with the thickening involving the whole wall; 3, Cartilage collenchyma, with walls thickened strongly all around and with a sharply differentiated inner lamella, so that the section resembles the section of cartilage, apparently separate tubes imbedded in a homogeneous matrix; 4, Plate collenchyma, with only tangential walls thickened; 5, Rift collenchyma, with only that portion of the wall thickened which borders on an intercellular space; 6, Metacollenchyma, formed by the slow death of the cell and the metamorphosis of the cell wall; and finally, 7, a form which resembles in shape the true hard bast, Protosclerenchyma (Haberlandt's "provisorisches Collenchym"). Collenchyma in general is to be considered as in its nature a water-storing tissue, but one which early acquires a mechanical function. It constitutes a supporting tissue not only during intercalary growth and entension of the organ, but remains particularly in herbaceous plants as a permanent mechanical tissue. Cf. *Ber. d. deutsch. Bot. Gesells.* viii. 150.

MESSRS. D. C. WORCESTER and F. S. Bowmer, recently of the University of Michigan, left July 22d for the Philippine Islands, where, through the large liberality of L. F. Menage, of Minneapolis, they will spend two years in the collection of scientific material. While the principal objects they intend to secure are birds and corals, they have determined to do considerable collecting in the line of fungi, paying particular attention to the *Sphæriodiæ* and *Gasteromycetes*. Mr. Worcester was instructor in botany for some time at the University of Michigan, and while there specialized upon the *Myxomycetes*, so results may be looked for in this line. The work on the material collected will be prosecuted at Minneapolis under the auspices of the Minnesota Academy of Sciences, in the museums of which all the collections will be deposited for the use of scientific men.

THE OUTER LAYER of the endosperm of the seeds of grasses has long been considered as a reservoir of nitrogenous substances, although several writers have suggested that it was either a conducting tissue for diastase or a ferment-producing layer. Dr. G. Haberlandt has now convinced himself by experimental researches that it can no longer be considered as belonging to the storage system, but that during the time of germination it produces and excretes diastase, belonging therefore to the glandular system. The anatomical structure of the "aleurone layer" during germination is exactly that of glandular cells. Moreover, a bit of this tissue separated from the grain and carefully washed will, if placed in contact with starch, corrode the grains and finally dissolve them, a result which was not obtained in control experiments. In order that this formation of diastase shall begin it is necessary that at least a portion of the embryo capable of growth should be present.

THE MOST detailed account that has yet appeared on the process of paraffin imbedding in plants is that given by Ludwig Koch in Pringsheim's Jahrbücher f. wiss. Botanik, xxi, 367–468. Exact directions are given for every step of the process, so that any one who can read them and do as he is told can not fail to secure good results. When, however, we come upon a detailed description of a microtome (5 pp.) we must own to surprise that such "padding" is permitted in this journal. Here is the way it begins: Der Körper des Mikrotoms besteht entweder aus vernickeltem Eisen oder aus Bronce. . . . An dem Körper des Instruments sind zwei Schlittenbahnen angebracht, u. s. w."! The last 60 pages contain an account of the various organs and tissues that the author has imbedded in this way, specifying the success, difficulties or failures with each. In spite of the extraordinary verbosity the paper will be extremely useful. The use of chloroform instead of turpentine in permeating the specimens with paraffin is recommended and we have found it economical of time.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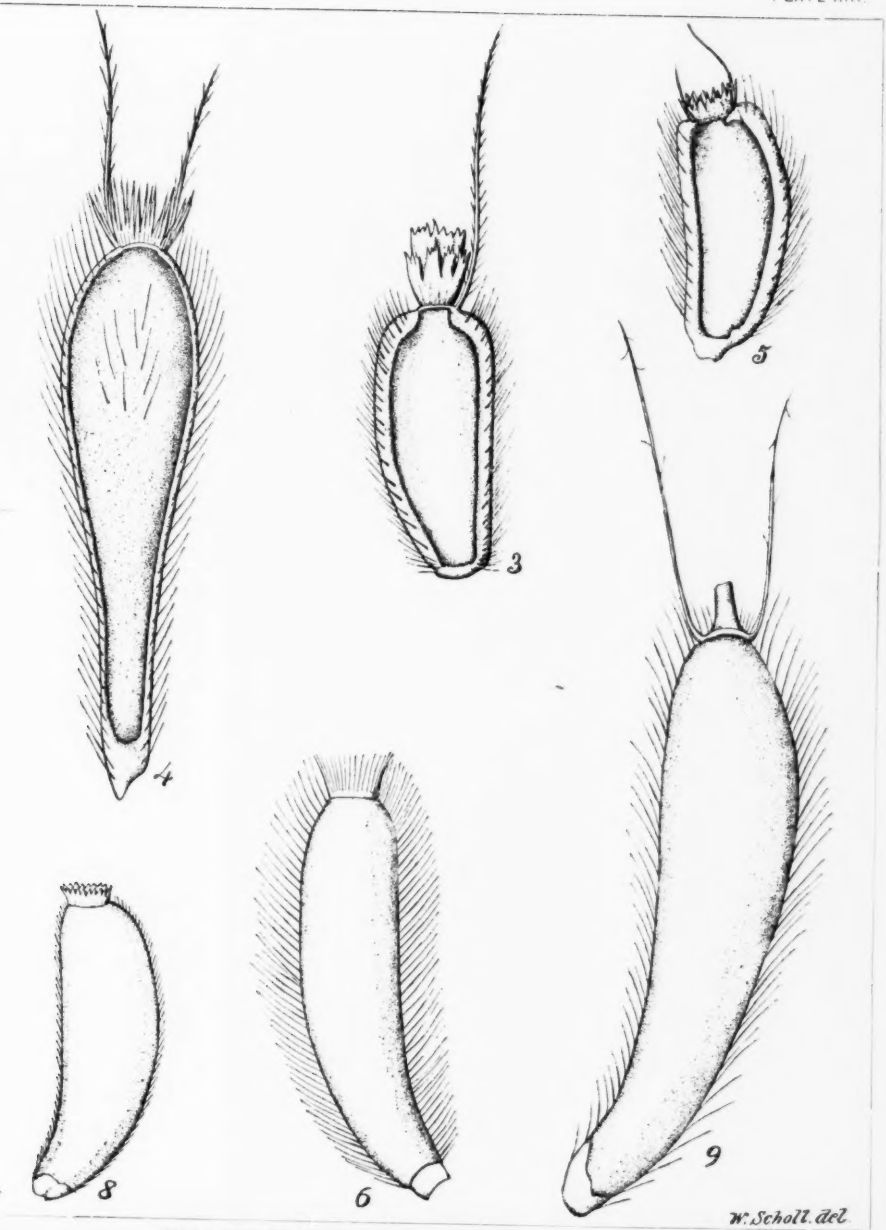

ROSE ON PERITYLE.